Minutes of the 26th Collimation Upgrade Specification Meeting, 16th of August 2013

Participants: A. Bertarelli (AB), R. Bruce (RB), F. Carra (FC), R. Kwee (RK), A. Lechner (AL), G. Maitrejean (GM), N. Mariani (NM), A. Marsili (AM) (scientific secretary), A. Rauni (AR), S. Redaelli (SR) (chairman), A. Ryazanov (AR) (NRC KI), A. Sytov (AS), R. Steinhagen (RS), C. Tambasco (CT).
Remote: J. Molson (JM), M. Serluca (MSe), W. Scandale (WS).

Indico event here.

1 Agenda of the WP5 for the annual meeting in Daresbury (S. Redaelli)

SR gave a short presentation of the tentative agenda for the WP5 part of the annual HiLumi workshop, which will take place in Daresbury (UK) from the 11th to the 14th of November 2013. The talks related to WP5 are planned over four parallel sessions. In addition, a joint session between the work packages 2, 3 and 5, regarding energy deposition. The proposed agenda, presented during this meeting is available here (pdf).

SR insisted on the fact that this planning can be changed and that feedback is encouraged. He mentioned that there is already a high number of talks.

The last day of the workshop will be dedicated to a special session for WP5, regarding mainly the technical details of the simulations. This is more for discussions than for formal presentations. This could take place in Manchester instead of Daresbury.

2 Status of BBC design and engineering: preliminary results (G. Maitrejean)

Slides are available in pdf or pptx.

2.1 Summary of the presentation

GM presented the status of the design study for the collimator with embedded wire for Beam–Beam compensation. One of the design constraints is to ensure the standard collimation functionality during operation; the wire would be used for machine development purposes.

Two designs are considered, which include one or two wires. The integration of these wires was given for both cases. The single–wire design only requires the jaw to be cut in two parts along the horizontal plane. The advantage is that this does not create any extra interface in the heat flow.

The two–wires design requires more advanced cutting of the jaw, hence creating a new interface and making the cooling less efficient. It has the advantage of providing a spare wire. The specifications for the wire were presented: they include a very good electrical conductor, but also a maximum admissible temperature. This could be an issue, and is being tested; it also adds constraints on the minimum size of the wire. Indeed, RS specified that the stainless steel layer might not be necessary, and might then add unnecessary space between the wire and the beam, making the compensator less efficient. This layer might be removed. Another issue might be the brittleness of the manganese oxide layer, impeding bending and installation.

The thermal load on the TCTP, for 1 hr beam lifetime, is given as 418.4 W. SR asked about the origin of this value; GM answered that it comes for old design simulations in FLUKA. In addition to the heat load from the beam, the heat coming from the Joule effect (for 350 A in the wire) must be taken into account. The total value is around 950 W. RS specified that this is the maximum possible current.

Thermal simulations were performed to evaluate the temperature of the wire in these conditions. Inside the jaw, the temperature of the wire stays low due to the jaw cooling system. However, outside the jaw volume, simulations show extremely high temperatures, far beyond the melting point. Extra thermal bridges have been designed to decrease this temperature. However, the available space between the cooling pipes is limited, especially at the point where the wire exits the jaw. Thermal bridges could not reach this point. Simulations show temperatures around 440°C. In addition, these simulations did not take into account the fact that the electric resistivity increases with temperature, making the wire temperature even higher.

In conclusion, both designs are not yet acceptable at 350 A; the working conditions would exceed the manufacturer specifications. The maximum possible current is 270 A for now. More design studies are ongoing.

2.2 Discussion

In addition to these considerations, SR pointed out that the designs must be validated mechanically (flatness etc.). Shock simulations must also be performed. SR added that a design should also be done for TCL, not only TCT.

RS suggested to increase the diameter of the wire outside the jaw volume to reduce heating.

AB asked if the ?Imax? can be reduced. SR suggested to not do this as this stage: more margins might be needed for MD (in particular as the wire is moving away from surface, i.e. further apart from beam)

He reminded that there will be a report to the HiLumi Technical Committee in September. It will be prepared off line.

3 Crystal routine studies (A. Sytov)

SR introduced AS, who is a Summer Student from the Belorussian State University and joined the team to work on a crystal routine developed at his institute.

Slides are available in pdf or pptx.

4 Summary of the presentation

AS presented the concepts and the code used for crystal channeling simulations, and its comparison with SixTrack simulations. The concept of the CRYSTAL–channeling code is to solve the equation of motion with inter–planar field potential, for a particle traveling in a crystal. The code has already been through several iteration. Cross-checks with measurements were performed. Similar simulations were ran in parallel with CRYAPR (Used by SixTrack).

Then, AS compared the results for the two codes. The simulations were done for an ideal crystal and a beam as generated by SixTrack (initial beam used in DM's work). The orientation was chosen to be optimal for the crystal edge. The difference between the two distributions of deflection angle were presented. One of these differences is a number of extra peaks or oscillations between the volume reflection peak and the channeling peak. This number corresponds to the number of oscillations that the particles will undergo in the crystal. This is not reproduced by CRYAPR.

AS then presented the horizontal kick distributions in amorphous orientation. The results are quite different from CRYAPR. However, the CRYAPR model has since been change. The ionization losses in amorphous orientation were also presented. SR pointed out that this is not relevant for LHC, because $\Delta E \simeq$ MeV; AS agreed. However, this effect will be much higher for ions. In addition, after being scattered, the particles have a trajectory that puts them in a good situation for volume reflection. AR asked which type of crystal is considered for the LHC. AS answered that it's silicon, and specified that the description in his code is an external input file which can easily be changed.

The crystal channeling can be improved by specific cuts presented here. This would decrease the amorphous peak and increase the channeling. SR pointed out that the cuts depends on the energy, so it wouldn't work for both injection and top energy. SR added that more detailed comparisons, including code by A. Taratin, will be performed. AR specified that the beam will actually create defects in the crystals, which are amorphous zones. Damage from interaction with 7 TeV p can be important and perturb the channeling.

AS presented the concept of Multiple Volume reflections. Small deflections can add up in certain directions, and has a large angular acceptance. It would lead to larger impact parameters. This is good because particles with small impact parameters might not be intercepted by absorbers. In addition, a majority of halo particles are deflected on first passage onto secondary collimators.

In conclusion, AS presented a systematic comparison with different crystal routines. Some difference in the physical treatment of the particles dynamic were found. The overall agreement is very good. The crystal cut can considerably increase the channeling efficiency and decrease inelastic losses in crystal. AS presented several aspects that could be tested with crystals in the LHC.

4.1 Discussion

RB asked if the differences between the two models could be tested with the SPS data. AS answered that he had already made simple SPS simulations with a simple tracking model. Indeed, the comparison with these data would be very interesting.